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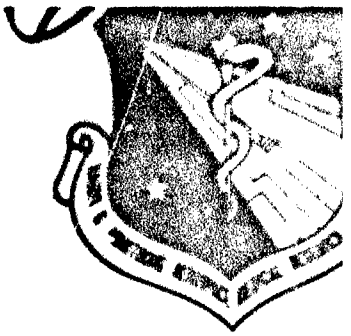

A MANUAL FOR ADMINISTERING A STANDARDIZED DEXTERITY TEST BATTERY (U)

CAY ERVIN

ANTHROPOLOGY RESEARCH PROJECT, INC.

KATHLEEN M. ROBINETTE

ARMSTRONG AEROSPACE MEDICAL RESEARCH LABORATORY

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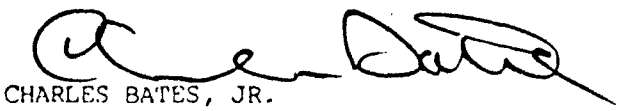

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This manual is the final product of an investigation which resulted in the development of a standardized battery of seven manual dexterity tests to be used in assessing the effects of chemical defense treatment drugs on performance. A companion report details how the tests were selected; this manual describes how to administer them. The battery includes the following tests: Purdue Pegboard Assembly, Aiming, Photoelectric Rotary Pursuit-Circle, Reaction Time, Nine-Hole Steadiness (two tests) and Tapping. [illegible] performance tests) therapy [illegible]

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Preface

This study was conducted by the Anthropology Research Project, Inc. under Air Force Contract F33615-85-C-0531 (Task 718408) with the U.S. Air Force Harry G. Armstrong Aerospace Medical Research Laboratory, Wright-Patterson Air Force Base, Ohio. Ms Ilse Tebbetts and Ms Belva Hardin, Anthropology Research Project, edited and prepared the manuscript for publication.

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A MANUAL FOR ADMINISTERING A STANDARDIZED DEXTERITY TEST BATTERY

INTRODUCTION

This manual is the final product of a study conducted to develop a standardized dexterity test battery to be used to evaluate the effects of chemical defense (CD) treatment drugs on manual performance. The battery which was developed represents a full range of dexterity abilities in a concise set of tests both easy and quick to administer. While the battery was developed for use in treatment drug evaluation, it is applicable to any hand dexterity studies in which two or more conditions are to be compared.

Numerous dexterity tests have been developed and employed since the turn of the century for a variety of purposes. It appeared, for many years, that a new test battery was developed for each new study. When investigators "borrowed" tests from previous studies, few followed any uniform procedures. Thus while two investigators seemingly employed the same test, the procedures were so different that results could not be directly compared.

Several years ago representatives of three U.S. military services recognized the need for standardizing procedures for testing performance decrement resulting from the use of CD treatment drugs. Unless such tests could be standardized, information gleaned about given drugs could not be directly compared to new drugs without repeated testing of the old ones. A tri-service committee was formed to develop such a standardized battery.

At the outset it was felt that the first battery should consist of tests already in existence. If any gaps or deficiencies remained, the set could later be expanded or improved. A review was made of readily available and previously developed tests (Ervin, in press), and all the tests which could be obtained were screened for face validity. After this initial screening approximately 40 tests remained. These were screened in a limited hands-on test procedure in which equipment durability and test reliability were examined. This resulted in a reduction in the number of candidate tests to 26. During the hands-on evaluation, refinements in the test administration procedures were made for those 26 tests that remained. One of the most frequent alterations was in the number of practice trials required to reach a learning curve plateau. However, subject instructions, scoring procedures, and other changes were also made to clarify the tests or to obtain a standardized, easily administered format.

Next, the 26 candidate tests were submitted to a larger-scale examination in which 118 subjects were employed. The results were examined using factor analysis methods to determine which tests essentially measured the same abilities. Factor analysis results indicated that there were seven separate factors or abilities represented by the tests. One test was selected from each group based upon relative factor loadings, and other considerations such as equipment durability, ease of administration and face validity. The analysis procedures and test selection rationale are described in a detailed companion report (Robinette et al., in press).

The abilities measured are described in the list of tests in Table 1 below.

TABLE 1

SKILL CATEGORIES OF TESTS

Test	Ability
Purdue Pegboard-Assembly	Manual dexterity: the ability to make skillful coordinated movements to grasp, move, or assemble objects both with and without tools.
Aiming	Aiming: the ability to visually locate and accurately place or follow objects.
Photoelectric Rotary Pursuit-Circle	Control precision: the ability to move controls to exact positions, repeatedly and accurately.
Reaction Time	Reaction time: the speed of response to a stimulus.
Nine-Hole Steadiness (2 tests)	Steadiness: the ability to keep the arm and hand steady.
Tapping	Speed: the ability to make fast repeated movements.

The purpose of this manual is to provide detailed easy-to-follow instructions for administering the seven tests. It includes descriptions of the equipment, background information about the tests (where applicable), information about the number of practice trials necessary to control for learning effects, modifications made to the original versions of the test (when applicable), and instructions for the subjects. Normative data drawn from 60 females (age range 18-58, average: 24) and 58 males (age range 18-67, average: 24) are given in Table 2. As with any such data, the reader is reminded that the norms are group-specific and caution should be used before generalizing the information to other groups.

While some of the tests were measured by increments of time, others were measured by pieces placed or assemblies completed. This resulted in smaller numbers indicating "better" scores on some tests, and larger numbers indicating "better" scores on others. In order for the "better" scores to be reflected in the same direction for all tests, the timed test scores were multiplied by -1 for the analysis. This simplified the interpretation of correlation coefficients and factor analysis results. Tests in which scores were converted in this way were the Reaction Time test, and both Nine-Hole Steadiness tests.

TABLE 2

NORMATIVE DATA

	Mean	Standard Deviation	Minimum	Maximum
Purdue Assembly (No. of pieces placed in 60 seconds)				
Males	45.26	6.27	26	63
Females	49.02	4.93	39	60
Aiming (No. of circles with dots placed in 30 seconds)				
Males	63.22	8.03	50	81
Females	63.37	8.30	44	86
Photoelectric-Circle (Amount of time in seconds on the target for 10 laps)				
Males	26.40	1.76	20.25	28.87
Females	24.77	2.66	14.64	28.11
Reaction Time (Seconds of response time)				
Males	.32	.04	.25	.42
Females	.34	.05	.26	.49
Nine-Hole Steadiness-Large (Total amount of error time in seconds for four holes)				
Males	.19	.24	0	1.01
Females	.13	.20	0	1.05
Nine-Hole Steadiness-Small (Total amount of error time in seconds for four holes)				
Males	.40	.58	0	2.32
Females	.56	.97	0	5.66
Tapping (No. of taps made in 10 seconds)				
Males	72.66	8.45	58	91
Females	68.43	6.84	47	81

The Purdue Pegboard, Nine-Hole Steadiness test, and the Photoelectric Rotary Pursuit and their accessories, are commercially available and were purchased from the Lafayette Instrument Company, Lafayette Indiana. The Aiming test, which is a paper and pencil test, was provided by Dr. Edwin A. Fleishman (1952). The Tapping and Reaction Time tests are computer tests which were programmed by Mr. Thomas Churchill and Ms. Mary Gross (both of Anthropology Research Project, Inc.).

The Nine-Hole Steadiness Test and the Photoelectric Rotary Pursuit are electronically scored and could easily be adapted for computer administration.

PURDUE ASSEMBLY

Description

The Purdue Pegboard (Figure 1) is a formica-covered piece of particle board with two columns of 25 holes each running down its length. Four wells which hold washers, pins and collars are lined up across one short end. The equipment included in the Pegboard can be used for four tests -- pin placement for the right, left and both hands, and assembly. Only the Assembly task is included in the battery.

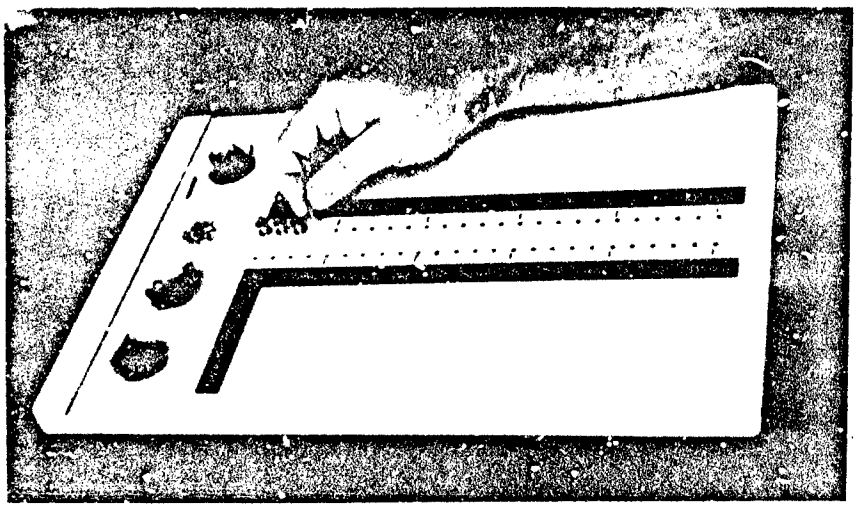

Figure 1. Purdue Pegboard.

The brochure which accompanies the test provides normative data for several groups of civilian applicants for employment. Caution, always advised before generalizing from any normative data, is especially advised here. Subjects on which these norms are based were given one or three practice trials which was found to be an insufficient number to control for learning effects in this study.

The Purdue Assembly test requires seated subjects to use both hands in an alternating fashion to place a pin in a hole on the board, then place a washer, a collar, and another washer over the pin. The test is scored by the number of parts placed in one minute. Thus, five completed assemblies and a partial assembly of two parts yield a score of 22. For this battery the scoring procedure was not changed, but the number of practice trials was increased from three to seven trials. More practice appeared to be required for subjects to learn the rhythmic pattern of movement needed to assemble parts in the right order with alternating hands. The starting position was standardized by having subjects begin with a pin in the right hand, the left hand empty, and both hands resting on the table (one on each side of the board). This test is performed the same way for all subjects, regardless of

handedness. The test administrator disassembles the pieces between practice trials to give the subject a rest.

The board is positioned so that the short edges are parallel with the edge of the table with the wells farthest from the subjects. The distance of the board from the edge of the table may be adjusted for arm length.

When giving instructions to subjects it is helpful if the experimenter also demonstrates the task. If subjects appear to have problems mastering the rhythm after the first one or two trials, offer suggestions and redemonstrate the test.

Subject Instructions

This test measures how quickly you can assemble four pieces using both hands in an alternating fashion. It is performed while seated at a table. You begin by inserting a rod into the board with your right hand, placing a washer over it with your left, putting on a collar with your right and another washer with your left. Your left hand works with the washers and your right hand alternates between the rods and the collars. As one hand is placing a piece, the other hand is picking up the next piece. In other words, at least one hand is always in motion. Your score is the number of pieces placed in one minute. Use the column closest to your dominant hand and work down the board. You will be given seven practice trials. Starting position is with a pin in your right hand, the left hand empty and with both hands resting on the table. There are plenty of extra pieces so if you drop a piece ignore it and return to the well for a new piece. If you knock a piece off after it has been placed it will be counted and does not have to be replaced.

The test administrator will disassemble the test between practice trials to give you a brief rest.

AIMING

Description

The Aiming paper and pencil test (Figure 2) is an 8 1/2" x 11" piece of paper with 20 rows of 10 circles each. The circles are 1/8 inch in diameter. A brief description accompanied the test which required some further standardization for this battery.

The object of this paper and pencil test is to place dots inside the small circles, as quickly as possible. The original instructions call for scoring by the number of dots successfully placed in 60 seconds. Many subjects, however, complained of monotony so the test was decreased to 30 seconds to reduce boredom. While no mention of practice trials was made in the original instructions, four trials are specified for this battery. Also, subjects use a soft-point felt-tip pen and are not allowed to angle the paper (the short edge should be parallel to the table edge but the distance from the table edge can be adjusted for arm length). Starting position is specified by having subjects begin with pen in hand, and the hand resting on the table beside the paper. Subjects are told to focus on accuracy rather

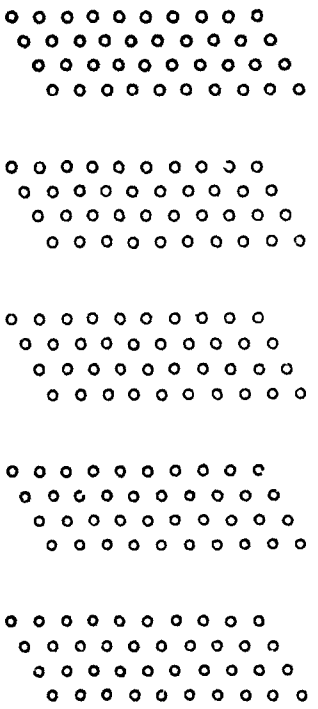

Figure 2. Aiming paper and pencil test (actual size is 8 1/2" x 11").

than on speed and should be reminded of this if more than five errors are recorded. For drug testing, the number of errors made by subjects may provide valuable additional information but this procedure has not previously been used for that purpose. The easiest way to score the test is to circle the errors, go back and count them, then subtract that number from the number of circles attempted.

Subject Instructions

This test measures how quickly and accurately you can place a single dot inside a small circle while seated. The dot must clearly be inside but may touch the line of the circle. Beginning in the top left-hand corner of the page (if you are right-handed) place a dot inside each circle working across the rows, from left to right. If you are left-handed begin in the top right-hand corner and work from right to left. You will be given four practice trials and will be scored by the number of circles successfully completed in 30 seconds. The emphasis is more on accuracy than on speed. Starting position is with the pen in your hand and your hand resting on the table.

PHOTOELECTRIC ROTARY PURSUIT

Description

The Photoelectric Rotary Pursuit (Figure 3) consists of a rotating opaque black disk, 12 1/2 inches in diameter, mounted over a light in a square box. The light can be seen through a three-quarter-inch-wide translucent strip which extends as a radius from the center of the disk to its perimeter. For the test, one of three opaque black glass plates containing three-quarter-inch translucent templates of various geometric shapes (circle, triangle or square) is fitted on the box over the disk. When the disk revolves under the template, the light coming through the narrow strip on the disk appears to move around the translucent shape outline on the black glass plate. The subject is given a six-inch long wand and is asked to use this to follow the light around the shape. Only the circle pattern is included in the battery. Accessory equipment includes a lap counter and two clocks (though only one clock is really necessary).

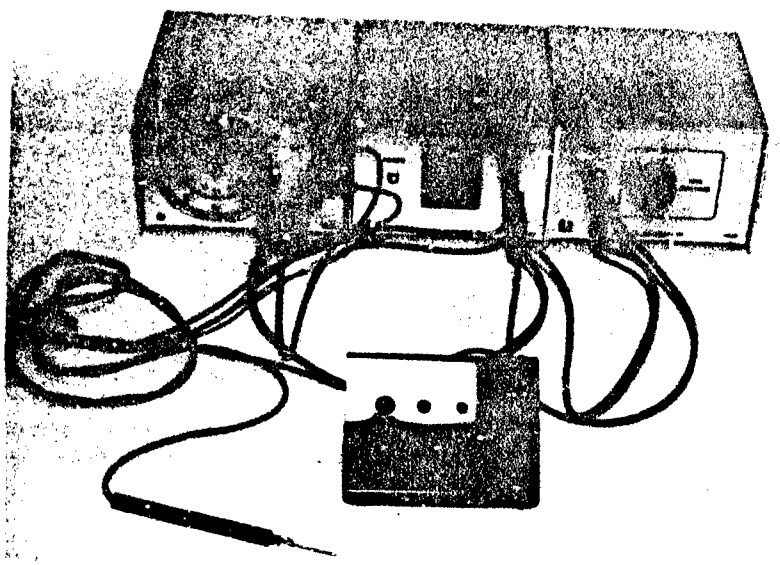

Figure 3. Photoelectric Rotary Pursuit.

Several aspects of the test are adjustable: the light can rotate either clockwise or counterclockwise; the speed at which the light moves can be set from 1 to 100 rounds per minute; and scoring can be done by the ratio of time the stylus is on or off the light. The test is for a specific length of time or a specific number of laps. Because of these possibilities for variation, several aspects required standardizing for this battery. It was decided to have subjects use the dominant hand and begin with the stylus held over the light which is positioned at the top (away from the controls) of the pattern. The speed is set at 20 rpm (slower speeds were found to be too easy) with the light moving in a clockwise pattern. Subjects are scored by the amount of time "on" the light for 10 laps. (Because the "off" time is in direct proportion to "on" time, scoring "off" times provided no additional

information.) Five practice trials are sufficient to control for learning effects.

This test is performed with subjects standing to the side of the box and the experimenter seated in front of the equipment.

Subject Instructions

This test measures how quickly you can follow a moving light with a stylus. The light begins at the top of the pattern and moves in a clockwise direction at a speed of 20 rpm. The stylus should be held directly over the light but does not need to be in contact with the glass. You will be given five practice trials of 10 laps each and will be scored by time on the target. Starting position is with the stylus held in your dominant hand with the point over the light. I will count to three before beginning, and will tell you when the last lap begins.

REACTION TIME TEST

Description

This test was developed specifically for this battery to provide a measure of eye-hand coordination speed. Though reaction time is inherent in many dexterity tests, a test which measured this skill alone did not appear to be currently available. The test requires a computer with a numeric keypad, and a software program to present the data described below.

The object of the Reaction Time test is to tap a key as soon as possible after seeing a visual stimulus. The time interval between the presentation of each stimulus ranges from .5 to 5 seconds. There are 10 stimuli in each trial, and three complete trials are given for practice. The test is scored by three variables: average reaction time, number of false starts, and number of errors. The study data revealed that very few numbers other than zero were recorded for false starts and errors. Therefore, these two scores are not statistically analyzed. However, they are recorded to emphasize to the subjects the need for accuracy, and as a check to ensure that a consistent accuracy is obtained under different drug conditions.

Subject Instructions

This test measures how quickly you can respond by tapping the #5 key after seeing a question mark on the screen. It is performed while seated at a table. The time interval between each stimulus presentation ranges from 1/2 to 5 seconds. There are 10 stimuli in each trial and you will be allowed three practice trials. You will use the index finger of your dominant hand and may rest your hand on the table. You may leave your finger above the key but not in contact with it. You will be scored by the average reaction time of the 10 presentations, the number of false starts (key is struck before stimulus is presented) and number of errors (wrong key is hit).

NINE-HOLE STEADINESS TEST

Description

The Nine-Hole Steadiness Test (Figure 4), is a metal plate with nine holes of gradually smaller sizes; diameters range from 0.5 to 0.078 inches. The object is to hold a stylus 0.06725 inches in diameter in each hole without touching the sides. The test can be used with an impulse counter, which counts the number of times the stylus touches the side, a stop clock which records the amount of time the stylus is in contact with the side, and a tone response which buzzes when the stylus touches the side, all of which are available through Lafayette Instrument Co. The impulse counter, however, does not appear to provide any valuable information (a subject could touch the side for the entire trial and only one error would be recorded) and so was not used. The stop clock and tone response were used in the study with an extension outlet equipped with a power switch.

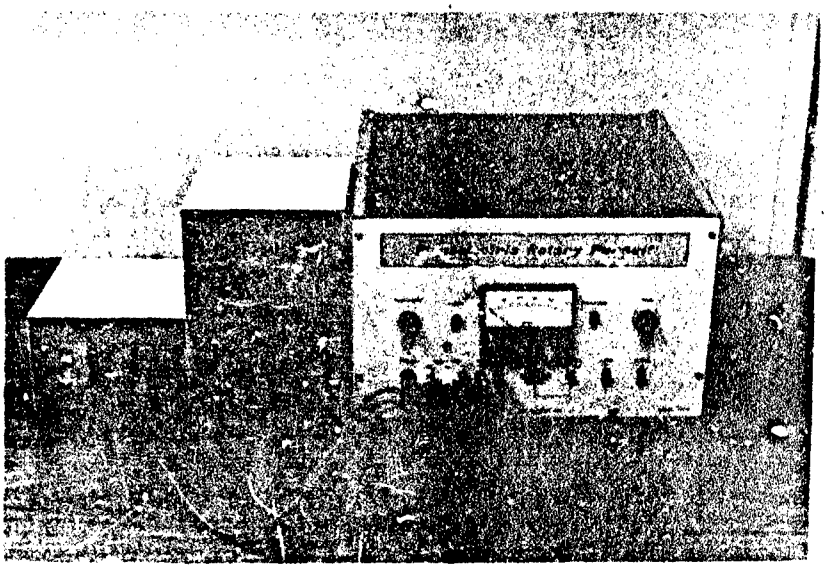

Figure 4. Nine-Hole Steadiness Test.

The brochure which accompanies the steadiness tester provides general information only (i.e. no specific instructions, background information, or normative data). It does state that the test can be used to study the effects of "exercise, handedness, smoking, or alcoholic ingestion."

Because no specific instructions accompanied the test, it can be performed in numerous ways. Initial investigation of this test revealed that steadiness is greatly dependent on whether subjects are allowed to rest their hands or whether the hand is held off the table top (and any other objects) which may serve to steady the hand. For this reason the test was divided into two tests: the Large Hole test for which the hand cannot be rested, and the Small Hole test for which it can be steadied.

The instructions accompanying this test lacked precision so a considerable amount of work was done to make it suitable for this battery. The instructions called for subjects to hold a stylus in the holes for "10-15 seconds". This range proved to be too wide and was standardized at exactly ten seconds. Because errors were often made entering and/or withdrawing from the holes, the 10-second time period is not begun until the stylus is inserted and subjects indicate that they are ready.

The largest and smallest holes were eliminated because they were too easy or virtually impossible, respectively. The center hole is used twice -- once with the Large Holes and once with the Small Holes test. Subjects are specifically instructed to hold the stylus by the red plastic handle to prevent static electricity shock. The test is scored by the total error time for each of the two tests. In the first, the four largest holes are used (Large-Holes Steadiness Test); the four smallest (Small-Holes Steadiness Test) are used in the second part. For the larger holes subjects are not permitted to rest their hands. For the smaller holes, they are allowed to rest their hands in any manner they find comfortable. Subjects are given two complete practice trials for each set of holes (alternating the large and small ones) to become familiar with the test.

Subject Instructions

This test measures how steadily you can hold a stylus in holes of gradually smaller sizes without touching the sides. Though there are nine holes, only seven will be used; the largest and the smallest of the holes will not be used. While seated at a table, position the metal frame so that the long edge is parallel with the table's edge and the holes are facing you. Holding the stylus in the dominant hand, insert the tip half-way through the hole. (Be sure to pick up the stylus by the red plastic part to avoid static electric shocks.) When you are ready, a 10-second timer will be started; when the bell sounds at the end of 10 seconds, you can pull the stylus out. Your scores will be the total error time for two sets of four holes--four large and four small. You will do the first four holes (the larger ones) with your hand unrested, and the last four (repeating the bottom left hole) resting your hand in any manner you choose. Holding your breath during the 10-second interval may help to steady your hand. You will be given two practice trials for each set. You may rest your hands in between holes.

TAPPING TEST

Description

The Tapping Test was designed specifically for this study in an attempt to obtain a "pure" measure of finger speed. It requires a computer with a numeric keypad and a software program to present the data as described below.

The object is to tap a key with the index finger of the dominant hand as many times as possible in a 10-second period. Since this test was designed for this study, no revisions were necessary.

Subject Instructions

This test is performed on a computer and measures how many times you can tap your finger in a 10-second period. You rest your hand on the table at which you are seated and may tap any key on the numeric key pad. The 0 key is closest to the edge but select the key you are most comfortable with. You will use the index finger of your dominant hand. Begin tapping when the computer instructs you to do so. You will be given three practice trials.

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